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ON THE TAUTOLOGY OF THE MATCHING LAW[1]

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The generalized matching law, that organisms divide their time between alternatives in proportion to the value of the reinforcement consequent on the choice, is derivable from the assumption that an organism choosing between alternatives is under no constraints except those the contingencies of reinforcement impose. Hence, the law is not subject to empirical test. Its value lies in its simple codification of assumptions underlying choice experiments.

I

Herrnstein (1961) allowed pigeons to choose between reinforcement scheduled by concurrent variable-interval schedules by pecking one of two keys. Choice was measured as relative rate of pecking. Herrnstein found:

$$\frac{P_L}{P_R}=\frac{R_L}{R_R} \qquad (1)$$

Where P_L, P_R = number of pecks on the left and right keys; and R_L, R_R = rate of reinforcement obtained by pecking on the left and right keys.

Premack (1965, 1969) and Baum and Rachlin (1969) have argued that a more general measure of behavior than pecks (P_L, P_R) would be time (T_L, T_R) as it is distributed among the alternatives.

Equation 1 would become:

$$\frac{T_L}{T_R}=\frac{R_L}{R_R} \qquad (2)$$

The right side of Equations 1 and 2 may also be generalized. Baum and Rachlin (1969) and Premack (1969) marshalled evidence to show that relative rate of reinforcement (R_L/R_R), amount of reinforcement (A_L/A_R) and immediacy of reinforcement (I_L/I_R) act multiplicatively to determine a single reinforcement value. Other parameters may well act multiplicatively in the same way. Thus,

$$\frac{T_L}{T_R}=\frac{R_L}{R_R}\cdot\frac{A_L}{A_R}\cdot\frac{I_L}{I_R}\cdot\frac{X_L}{X_R}=\frac{V_L}{V_R} \qquad (3)$$

Where X_L, X_R = parameters of reinforcement other than rate, amount, and immediacy; and V_L, V_R = value of reinforcement consequent on left and right alternatives.

Equation 3 is a general statement of the matching law. It says that preference for one alternative over another equals the reinforcement consequent upon choosing that alternative as a fraction of the reinforcement consequent upon choosing the other.

Baum and Rachlin (1969) and Premack (1965, 1969) discuss evidence for and against this generalization of the matching law. I will argue that such evidence is not relevant to the law because, despite its empirical origin, it is not an empirical law.

The extent to which a law is empirical can be evaluated by asking the question: what sort of evidence could disprove the law? If no conceivable evidence could disprove the law, it is not an empirical law but a restatement of assumptions made prior to empirical test.

II

One sort of evidence that could not bear on the truth of the matching law is that obtained where constraints prohibit free choice between the alternatives. We might consider a rat in a Skinner box as free to choose whether or not to press the bar. However, should we reach in, lift the rat's paw onto the bar and press it down ourselves, the rat would not be free to choose. Similarly, if we should find some

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stimulus other than our hand that reliably elicited bar-pressing, the rat would be equally constrained.

This is not to say that no conceivable constraints can be present in the experimental situation. Once the laws of behavior are discovered, the organism is seen to have been constrained all the while and not free to choose. The only way out of this seeming contradiction is to reserve the term "choice" for only a certain kind of constraint—that imposed by contingencies of reinforcement. Thus, any law of choice such as the matching law must be a law of contingencies (*i.e.*, a law regarding operant behavior only).

III

Another sort of evidence that could not bear on the truth of the matching law is that based on scheduled reinforcements. The matching law is said to be about obtained rather than scheduled reinforcements (Herrnstein, 1970). This distinction is reasonable but it has several important implications. Considering obtained reinforcements only, one can account for many experimental results that apparently fail to conform to the matching law. For instance, when two ratio schedules are arranged concurrently, organisms usually fail to match their responding to any parameter of the schedules, but spend 100% of the time responding on the smaller ratio. In the 100% to 0% case, however, all (100%) of the *obtained* reinforcements come from the response chosen 100% of the time, and the matching relation is preserved.

The obtained-scheduled distinction must be extended further, however, to account for all possible situations. Premack (1965) pointed out that obtained reinforcement does not always equal reinforcement delivered, but only that part actually consumed. Furthermore, when a choice is made between different substances (*e.g.*, grape juice *vs.* orange juice) relative obtained reinforcement value will not equal relative amount consumed. Here, the notions of *obtained reinforcement* and *reinforcement value* are one and the same.

Thus, evidence that appears to disconfirm the matching law can be (a) discounted as elicited and hence not responsive to the contingencies, (b) discounted as determining scheduled reinforcement rather than that actually obtained.

IV

It is apparent that the left-most term of Equation 3 is simply a measure of the right-most term. Since no constraints except reinforcement value are assumed to be affecting choice, choice is assumed to be a direct measure of reinforcement value. Thus, Equation 3 is not an empirical law, but a statement of how reinforcement value is measured. For instance, assume X_L and X_R to be parameters of schedules between which an organism chooses and that the following relationship applies between behavior and these parameters:

$$\frac{T_L}{T_R} = \log \frac{X_L}{X_R}$$

If data had seemed to support such an expression we would have been forced to postulate another relationship:

$$\frac{V_L}{V_R} = \log \frac{X_L}{X_R}$$

and, thus, still retain equality between the left-most and right-most terms of Equation 3.

If an organism chooses A twice as often as B, given no other constraints, it must be because it likes A twice as much as B. Otherwise, we would assume that there was something wrong either with our measure of choice or with our determination of relative reinforcement value.

If we found an organism choosing A over B 2:1, but reinforcements delivered were only 1.5:1 we should have to invent other reinforcers. In fact, this is exactly what Herrnstein (1970) has done. In the case of a single manipulandum, where an organism chooses between responding and not responding, a hypothetical reinforcement for not responding is assumed. Similarly, in multiple schedules where conditions of reinforcement in one component affect responding in another, a trace of reinforcement from one component is said to be present in the other.

V

It is true that in a surprising number of cases (as in Herrnstein's original experiments), there is also a 1:1 correspondence between measured reinforcements (the middle term of Equation 3) and behavior (the left-most

term). This is a tribute to Herrnstein's experimental techniques. It says that the reinforcements he measured either effectively exhausted the reinforcement values in the situation or were proportional to them. But it should not surprise us when this relationship is not 1:1.

There have been several recent objections to the matching law on empirical grounds (Shimp, 1966; Staddon, 1968; Fantino, 1969; Killeen, 1970). These studies have provided valuable data on the relationship between scheduled reinforcements and their values, but they do not constitute an attack on the matching law (which can be neither attacked nor defended on empirical grounds) unless that law refers to scheduled experimental parameters. But the most cursory examination of data will show that scheduled parameters do not determine choice and we cannot expect them to do so, especially where different reinforcers are compared. It would be well, therefore, to focus future investigations on the manipulations necessary to confirm the law, rather than on whether the law is true.

VI

Given that the matching law is tautologous, of what use is it? We should not be discouraged, because non-empirical laws have their uses. Consider, for instance, the First Law of Thermodynamics. This says that the energy within a system equals the energy input minus the energy output. It is as difficult to imagine a system that violates the First Law of Thermodynamics as to imagine an unconstrained choice not governed strictly by reinforcement contingencies. Where the First Law of Thermodynamics is apparently disconfirmed, engineers and physicists assume that they have overlooked some source of energy and they set about to find it. The value of the law is that it tells them when to look and when to stop looking. Similarly, the matching law circumscribes our search for reinforcers in any situation.

Let me cite an example from personal experience. Baum and I were trying to train pigeons to run from one side to the other of a large shuttle box with food magazines on the two sides. Our first concern was that with equal reinforcement on the two sides, the pigeons should spend equal amounts of time on the two sides. Accordingly, we varied (simultaneously on the two sides) contingencies, changeover delays, stimuli in the box, and reinforcement parameters until the pigeons approximately divided their time equally between the two sides. Thereafter, we varied rates of reinforcement differentially, keeping all other conditions constant, and observed the relative durations the pigeons stayed on either side. At first we were hesitant to vary parameters in the 50:50 condition so that behavior would be balanced, thinking that we were assuming our results before we started. But, we later realized that our results would not affect our assumptions about Equation 3, but only our assumptions about our own experiment. The more our results approximated Equation 3, the surer we were that we had eliminated or balanced extraneous reinforcers in the situation. This led us to concentrate on the reinforcers in the situation rather than on confirmation or disconfirmation of Equation 3.

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